CLAIMS:

1. A method of operating an image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions, the method comprising the steps of:

(a) determining the viewing volume for each camera position;

(b) determining the volume bounded by the intersection of the viewing volumes; and

(c) setting the bounded volume as an initial space for use in deriving a representation of a three-dimensional surface of the object using said images.

2. A method according to claim 1, further comprising the step (d) of dividing the bounded volume into voxels to form an initial voxel space.

3. A method according to claim 2, further comprising:

(e) determining, for each voxel that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is visible;

(f) comparing characteristics of each of the image areas corresponding to the same voxel;

(g) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent; and

(h) repeating steps (e) to (g) until all non-occluded voxels having inconsistent characteristics have been removed.

4. In an image processing apparatus having a processor for processing image data representing images of an object taken from a plurality of different camera positions, a method of processing image data to derive a representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) determining the viewing volume for each camera position at which an image was taken;

(b) determining the volume bounded by the intersection of the viewing volumes;

(c) defining the bounded volume as an initial voxel space formed of voxels;

(d) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is represented;

(e) comparing characteristics of each of the image areas corresponding to the same voxel;

(f) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent; and

(g) repeating steps (d) to (f) until all non-occluded voxels having inconsistent characteristics have been removed.

5. A method according to claim 1, wherein the step of determining the viewing volume for a camera position comprises determining the viewing volume using data representing a camera focal point and a camera imaging area for that camera position.

6. A method according to claim 5, wherein the step of determining the viewing volume includes projecting straight lines from the focal point through points on the boundary of the imaging area.

7. A method according to claim 1, wherein the step of defining the intersection of the viewing volumes comprises (i) determining an initial intersection of the viewing volumes of first and second camera positions, (ii) determining the intersection of that intersection with another viewing volume and setting that intersection as the current intersection and (iii) repeating steps (i)

and (ii) until the viewing volumes for all camera positions have been considered.

8. In an image processing apparatus having a processor for processing image data representing images of an object taken from a plurality of different camera positions, a method of processing image data to derive a representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) defining a volume containing the object as an initial space formed of voxels;

(b) accessing data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the same voxel;

(e) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent thereby producing a smaller voxel volume;

(f) repeating steps (c) to (e) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space;

(g) accessing data representing a further image of the object recorded at a different camera position from the first set of images;

(h) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in the further image;

(i) comparing the characteristic of the image area of the further image with the characteristic already associated with that voxel;

(j) removing a voxel in response to an inconsistency in the compared characteristics, thereby producing a smaller voxel space;

(k) repeating steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as a modified representation of the three-dimensional object surface.

9. A method according to claim 8, which further comprises repeating steps (g) to (k) for each of a series of further images.

10. A method according to claim 8 or 9, which further comprises discarding the first set of images after step (f).

11. A method according to claim 8, which comprises carrying out steps (g) to (j) by:

accessing data representing a number of further images of the object recorded at different camera positions from one another and the first set of images at step (g);

determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each of the further images at step (h);

comparing the characteristics of the image areas of the further images with the characteristic already associated with that voxel at step (i);

removing a voxel in response to an inconsistency in the compared characteristics thereby producing a smaller voxel space at step (j).

12. In an image processing apparatus having a processor for processing image data representing images of an object taken from a plurality of different camera positions, a method of processing image data to derive a representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) defining a volume containing the object as an initial voxel space formed of voxels;

(b) accessing data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the same voxel;

(e) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent, thereby producing a smaller voxel volume;

(f) repeating steps (c) to (e) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as a representation of the three-dimensional object surface,

together with the characteristic associated with each non-occluded voxel of the resulting voxel space;

(g) accessing data representing a second set of images consisting of a sub-set of the first set and a further image of the object recorded at a different camera position from the first set of images;

(h) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each of the second set of images;

(i) comparing the characteristics of the image areas in each of the second set of images;

(j) removing a voxel in response to an inconsistency in the compared characteristics, thereby producing a smaller voxel space;

(k) repeating steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as a modified representation of the three-dimensional object surface.

13. A method according to claim 12, which further comprises repeating steps (g) to (k) for each of a series of further images and changing the second set of images accessed in step (g) with each repetition.

14. A method according to claim 13, which comprises changing the second set of images at each repetition by adding a further image from the first set of images.

15. A method according to claim 13, which comprises changing the second set of images at each repetition by discarding at least one of the sub-set of the first set and including in the second set the further image accessed at the previous step (g).

16. In an image processing apparatus having a processor for processing image data representing images of an object taken from a plurality of different camera positions, a method of processing image data to derive a representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) checking to see if a voxel meets at least one criterion by projecting that voxel into at least one of the images;

(d) if the voxel does not meet said at least one

criterion, dividing the voxel into subsidiary voxels; and

(e) then checking to see if the subsidiary voxels meets at least one criterion by projecting the subsidiary voxels into at least one of the images.

17. A method according to claim 16, further comprising deciding that a sub-voxel does not form part of the three-dimensional surface and so should be removed if the sub-voxel does not meets said at least one criterion.

18. A method according to claim 16, further comprising repeating steps c, d and e for any sub-voxel that does not meet said at least one criterion.

19. A method according to claim 16, wherein the at least one criterion comprises any one or more of the following:

1) the colour variance in a pixel patch to which the voxel projects in an image has a value lower than a predetermined value;

2) the difference in colour or average colour between pixel patches to which the voxel projects in different images has a standard deviation less than a predetermined value; and

3) the voxel is not partially occluded by a voxel or subsidiary voxels of smaller size than the voxel.

20. In an image processing apparatus having a processor for processing image data representing images of an object taken from a plurality of different camera positions, a method of processing image data to derive a representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) determining the area corresponding to a given voxel in each image in which the voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the given voxel;

(e) deriving from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel.

(f) sub-dividing a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and repeating steps (c) to (e) for each subsidiary voxel.

21. A method according to claim 20, further comprising:

(g) in response to a subsidiary voxel having a derived value exceeding a threshold value and a size greater than a minimum size, sub-dividing that subsidiary voxel into subsidiary voxels and repeating steps (c) to (e) for each subsidiary voxel of that subsidiary voxel; and

(h) removing any subsidiary voxel of the minimum size having a derived value exceeding the threshold value.

22. A method according to claim 20, which comprises repeating steps (c) to (h) until the degree of inconsistency for all non-occluded voxels and subsidiary voxels is below a predetermined value.

23. In an image processing apparatus having a processor for processing image data representing images of an object taken from a plurality of different camera positions, a method of processing image data to derive a representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with

respect to the object which data provides a colour value for each pixel of each image;

(c) determining the area corresponding to a voxel in each image in which the voxel is visible;

(d) determining a colour space value for each pixel of each area where each colour space value encompasses a range of pixel colour values;

(e) comparing the colour space values for each of the image areas corresponding to the same voxel; and

(f) removing the voxel only if the image areas do not share at least one colour space value.

24. In an image processing apparatus having a processor for processing image data representing images of an object taken from a plurality of different camera positions, a method of processing image data to derive a representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) determining the area corresponding to a voxel in each image in which that voxel is visible;

(c) comparing characteristics of each of the image areas corresponding to the voxel; and when the derived value for a voxel exceeds a threshold value:

(i) sub-dividing the voxel into subsidiary voxels;

(ii) determining the region corresponding to each sub-voxel in each image in which that sub-voxel is visible;

(iii) comparing characteristics of the image regions; and

(iv) removing the voxel only if there is no set of regions which contains a region from each image and for which the characteristics are not inconsistent.

25. A method according to of claim 4, wherein the step of determining the area corresponding to a voxel in an image comprises projecting the voxel into each image.

26. A method according to claim 4, wherein the step of comparing characteristics of the image areas or regions comprises comparing colours of the image areas or regions.

27. A method according to claim 4, which further comprises outputting a signal carrying data defining the initial space or the voxel representation of the three-dimensional object surface.

28. A method according to claim 4, which further comprises providing a computer storage medium storing data defining the initial space or the voxel representation of the three-dimensional object surface.

29. A method according to claim 4, further comprising generating texture data for rendering onto the representation of the three-dimensional object surface.

30. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions, the apparatus comprising:

means for determining the viewing volume for each camera position;

means for determining the volume bounded by the intersection of the viewing volumes; and

means for setting the bounded volume as an initial space for use in deriving a representation of a three-dimensional surface of the object using said images.

31. Apparatus according to claim 30, further comprising means for dividing the bounded volume into voxels to form an initial voxel space.

32. Apparatus according to claim 31, further comprising processor means operable:

(i) to determine, for each voxel that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is visible;

(ii) to compare characteristics of each of the image areas corresponding to the same voxel; and

(iii) to remove each non-occluded voxel having inconsistent image area characteristics so as to provide a representation of the three-dimensional object surface.

33. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

means for determining the viewing volume for each camera position at which an image was taken;

means for determining the volume bounded by the intersection of the viewing volumes;

means for dividing the bounded volume into voxels to form an initial voxel space; and

processor means operable:

(i) to determine, for a voxel that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is represented;

(ii) to compare characteristics of each of the image areas corresponding to the same voxel; and

(iii) to remove a voxel when the characteristics of the image areas corresponding to that voxel are inconsistent.

34. Apparatus according to claim 30, wherein the means for determining the viewing volume for a camera position is arranged to determine the viewing volume using data representing a camera focal point and camera imaging area for that camera position.

35. Apparatus according to claim 34, wherein means for determining the viewing volume includes means for projecting straight lines from the focal point through points on the boundary of the imaging area.

36. Apparatus according to claim 30, wherein the means for defining the intersection of the viewing volumes is arranged (i) to determine an initial intersection of the viewing volumes of first and second camera positions, (ii) to determine the intersection of that intersection

with another viewing volume and to set that intersection as the current intersection and (iii) to repeat (i) and (ii) until the viewing volumes for all camera positions have been considered.

37. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

means for defining an initial volume containing the object as an initial space formed of voxels, and processor means operable:

(i) to access data representing a first set of images of the object each recorded at a respective one of a number of different camera positions with respect to the object;

(ii) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(iii) to compare characteristics of each of the image areas corresponding to the same voxel to remove any voxel have inconsistent characteristics and to store the resulting voxel space as a representation of the three-

dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space;

(iv) then to access data representing a further image of the object recorded at a different camera position from the first set of images;

(v) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in the further image;

(vi) to compare the characteristic of the image area in the further image with the characteristic already associated with that voxel;

(vii)to remove any voxel for which the characteristic of the image area of the further image is inconsistent with that already associated with that voxel; and

(viii)to store the resulting voxel space as modified representation of the three-dimensional object surface.

38. An apparatus according to claim 37 wherein the processor means is operable to carry out steps (iv) to (viii) for each of a series of further images.

39. An apparatus according to claim 37, wherein the processor means is operable to cause the first set of

images to be discarded after the processor means has stored the resulting voxel space.

40. An apparatus according to claim 37, wherein the processor means is operable to access data representing a plurality of further images and to carry out steps (iv) to (viii) using all of the further images.

41. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

means for defining an initial volume containing the object as an initial voxel space formed of voxels; and

processor means operable:

(i) to access data representing a first set of images of the object each recorded at a respective different one of a number of different camera positions with respect to the object;

(ii) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(iii)to compare characteristics of each of the image areas corresponding to the same voxel;

(iv) to remove any voxel having inconsistent characteristics and to store the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space;

(v) then to access data representing a second set of images consisting of a sub-set of the first set and a further image of the object recorded at a different camera position from the first set of images;

(vi) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the second set;

(vii)to compare the characteristics of the image areas of second set;

(viii)to remove any voxel having inconsistent characteristics in the second set of images to store the resulting voxel space as an updated representation of the three-dimensional object surface.

42. Apparatus according to claim 41, wherein the processor means is operable repeat steps (v) to (viii) for each of a series of different sets of images.

43. Apparatus according to claim 42, wherein the processor means is operable to change the second set of images at each repetition by adding a further image not forming part of the first set of images.

44. Apparatus according to claim 42, wherein the processor means is operable to change the second set of images at each repetition by discarding at least one of the sub-set of the first set of images and to include in the second set at least one newly accessed further image.

45. In an image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

means for defining an initial volume containing the object surface as an initial space formed of voxels;

means for accessing data representing images of the object recorded at different camera positions with respect to the object; and

processor means operable:

(c) to check to see if a voxel meets at least one criterion by projecting that voxel into at least one of the images;

(d) if the voxel does not meet said at least one criterion, to divide the voxel into subsidiary voxels; and

(e) then to check to see if the subsidiary voxels meets at least one criterion by projecting the subsidiary voxels into at least one of the images.

46. Apparatus according to claim 45, wherein the processor means is operable to decide that a sub-voxel does not form part of the three-dimensional surface and so should be removed if the sub-voxel does not meets said at least one criterion.

47. Apparatus according to claim 45, wherein the processor means is operable to repeat c, d and e for any sub-voxel that does not meet said at least one criterion.

48. Apparatus according to claim 45, wherein the at least one criterion comprises any one or more of the following:

4) the colour variance in a pixel patch to which the voxel projects in an image has a value lower than a predetermined value;

5) the difference in colour or average colour

between pixel patches to which the voxel projects in different images has a standard deviation less than a predetermined value; and

6) the voxel is not partially occluded by a voxel or subsidiary voxels of smaller size than the voxel.

49. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

means for defining an initial volume containing the object surface as an initial space formed of voxels;

means for accessing data representing images of the object recorded at different camera positions with respect to the object; and

processor means operable:

(i) to determine the area corresponding to a given voxel in each image in which the voxel is visible;

(ii) to compare characteristics of each of the image areas corresponding to the given voxel;

(iii)to derive from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel;

(iv) to sub-divide a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and to repeat steps (i) to (iii) for each subsidiary voxel;

(v) in response to a subsidiary voxel having a derived value exceeding a threshold value and a size greater than a minimum size, to sub-divide that subsidiary voxel into subsidiary voxels and to repeat (i) to (iii) for each subsidiary voxel of that subsidiary voxel;

(vi) to remove any subsidiary voxel of the minimum size having a derived value exceeding the threshold value; and

(vii) to repeat (i) to (vi) for each voxel that is not occluded by another voxel to provide a representation of the three-dimensional object surface consisting of the remaining non-occluded voxels and subsidiary voxels.

50. Apparatus according to claim 49, wherein the processor means is operable to repeat (i) to (vi) until the degree of inconsistency for all non-occluded voxels is below a predetermined value.

51. An image processing apparatus for processing image data representing images of an object taken from a

plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

means for defining an initial volume containing the object surface as an initial space formed of voxels;

means for accessing data representing images of the object recorded at different camera positions with respect to the object which data provides a colour value for each pixel of each image; and

processor means operable:

(a) to determine the area corresponding to a voxel in each image in which that voxel is visible;

(b) to determine a colour space value for each pixel of each area where each colour space value encompasses a range of pixel colour values;

(c) to compare the colour space values for each of the image areas corresponding to the same voxel; and

(d) to remove the voxel only if the image areas do not share at least one colour space value.

52. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions, a method of processing image data to derive a representation of a

three-dimensional surface of the object, the apparatus comprising:

means for defining an initial volume containing the object surface as an initial space formed of voxels;

means for accessing data representing images of the object recorded at different camera positions with respect to the object; and

processor means operable:

(a) to determine the area corresponding to a voxel in each image in which that voxel is visible;

(b) to compare characteristics of each of the image areas corresponding to the same voxel; and

(c) to derive from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the voxel and, when the derived value for a voxel exceeds a threshold value,

(i) to sub-divide the voxel into subsidiary voxels,

(ii) to determine the region corresponding to each sub-voxel in each image in which that sub-voxel is visible,

(iii) to compare characteristics of the image regions, and

(iv) to remove the voxel only if there is no set of regions which contains a region from each image and for which the characteristics are not inconsistent.

53. Apparatus according to claim 30, wherein the processor means is operable to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is represented or visible by projecting the voxel into the image.

54. Apparatus according to claim 30, wherein the processor means is operable to compare characteristics of each of the image areas corresponding to the same voxel by comparing the colours of each of the image areas.

55. Apparatus according to claim 30, further comprising means for outputting a signal carrying data defining the initial space or the voxel representation of the three-dimensional object surface.

56. Apparatus according to claim 30, further comprising means for providing a computer storage medium storing data defining the initial space or the voxel representation of the three-dimensional object surface.

57. Apparatus according to claim 30, further comparing means for generating texture data for rendering onto a representation of the three-dimensional object surface.

58. A method according to claim 16, which further comprises:

accessing data representing a further image of the object recorded at different camera position; and then repeating steps of ~~any one of claims 16 to 23~~ claim 16 using that further image.

59. A method according to claim 16, which further comprises:

accessing data representing a set of images consisting of a sub-set of the images accessed at step (b) and a further image of the object recorded at a different camera position;

repeating steps of ~~any one of claims 16 to 23~~ claim 16 using that set of images.

60. A method according to claim 8, which comprises defining the initial space using a method as set out in claim 1.

61. Apparatus according to claim 48, wherein the processor means is also operable:

to access data representing a further image of the object recorded at a different camera position and then to repeat steps set out in ~~any one of claims 48 to 52~~ claim 48 using that further image.

62. Apparatus according to claim 48, wherein the processor means is also operable:

to access data representing a set of images consisting of a sub-set of images previously accessed and a further image of the object recorded at a different camera position and then to repeat steps set out in ~~any one of claims 48 to 52~~ claim 48 using that set of images.

63. Apparatus according to claim 48, wherein the processor means is operable to define the initial space as set out in any one of claim 30.

64. A storage medium carrying processor implementable instructions for causing processing means to carry out a method in accordance with claim 1.

65. A signal carrying processor implementable instructions for causing processing means to carry out a method in accordance with claim 1.

66. A storage medium carrying processor implementable instructions for causing processing means to become configured to form apparatus in accordance with claim 30.

67. A signal carrying processor implementable instructions for causing processing means to become configured to form apparatus in accordance with any one of claim 30.

68. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, a method of processing the image data to derive a computer representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) determining the viewing volume for each camera position at which an image was taken;

(b) determining the volume bounded by the intersection of the viewing volumes;

(c) defining the bounded volume as an initial voxel space formed of voxels;

(d) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is shown;

(e) comparing characteristics of each of the image areas corresponding to the same voxel;

(f) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent; and

(g) repeating steps (d) to (f) until all non-occluded voxels having inconsistent characteristics have been removed.

69. In a method of processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and camera positions to generate the three-dimensional computer model, an improvement comprising processing the image data to derive a computer representation of a three-dimensional surface of the object by:

(a) determining the viewing volume for each camera position at which an image was taken;

(b) determining the volume bounded by the intersection of the viewing volumes;

(c) defining the bounded volume as an initial voxel space formed of voxels;

(d) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is shown;

(e) comparing characteristics of each of the image areas corresponding to the same voxel;

(f) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent; and

(g) repeating steps (d) to (f) until all non-occluded voxels having inconsistent characteristics have been removed.

70. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, apparatus for

processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising:

a processor configured by processor instructions to operate:

to determine the viewing volume for each camera position at which an image was taken;

to determine the volume bounded by the intersection of the viewing volumes;

to divide the bounded volume into voxels to form an initial voxel space;

to determine for a voxel that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is represented;

to compare characteristics of each of the image areas corresponding to the same voxel; and

remove a voxel when the characteristics of the image areas corresponding to that voxel are inconsistent.

71. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, an improvement

comprising apparatus for processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising a processor configured by processor instructions to operate:

to determine the viewing volume for each camera position at which an image was taken;

to determine the volume bounded by the intersection of the viewing volumes;

to divide the bounded volume into voxels to form an initial voxel space;

to determine, for a voxel that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is represented;

to compare characteristics of each of the image areas corresponding to the same voxel; and

to remove a voxel when the characteristics of the image areas corresponding to that voxel are inconsistent.

72. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, a method of processing

the image data to derive a representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) defining a volume containing the object as an initial space formed of voxels;

(b) accessing data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the same voxel;

(e) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent thereby producing a smaller voxel volume;

(g) accessing data representing a further image of the object recorded at a different camera position from the first set of images;

(h) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in the further image;

(i) comparing the characteristic of the image area of the further image with the characteristic already associated with that voxel; and

(j) removing a voxel in response to an inconsistency in the characteristics compared at step (i), thereby producing a smaller voxel space.

73. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, a method of processing the image data to derive a computer representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) defining a volume containing the object as an initial space formed of voxels;

(b) accessing data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the same voxel;

(e) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent, thereby producing a smaller voxel volume;

(g) accessing data representing a second set of images consisting of a sub-set of the first set and a further image of the object recorded at a different camera position from the first set of images;

(h) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each of the second set of images;

(i) comparing the characteristics of the image areas in each of the second set of images; and

(j) removing a voxel in response to an inconsistency in the characteristics compared at step (i), thereby producing a smaller voxel space.

74. In a method of processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional

computer model, an improvement comprising processing the image data to derive a computer representation of a three-dimensional surface of the object by:

(a) defining a volume containing the object as an initial space formed of voxels;

(b) accessing data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the same voxel;

(e) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent thereby producing a smaller voxel volume;

(g) accessing data representing a further image of the object recorded at a different camera position from the first set of images;

(h) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in the further image;

(i) comparing the characteristic of the image area of the further image with the characteristic already associated with that voxel; and

(j) removing a voxel in response to an inconsistency in the characteristics compared at step (i), thereby producing a smaller voxel space.

75. In a method of processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, an improvement comprising processing the image data to derive a computer representation of a three-dimensional surface of the object by:

(a) defining a volume containing the object as an initial voxel space formed of voxels;

(b) accessing data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the same voxel;

(e) removing a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent thereby producing a smaller voxel volume;

(g) accessing data representing a second set of images consisting of a sub-set of the first set and at least one further image of the object recorded at a different camera position from the first set of images;

(h) determining, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each of the second set of images;

(i) comparing the characteristics of the image areas in each of the second set of images; and

(j) removing a voxel in response to an inconsistency in the characteristics compared at step (i), thereby producing a smaller voxel space.

76. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the

three-dimensional computer model, apparatus for processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising:

a processor configured by processor instructions to operate:

(a) to define a volume containing the object as an initial space formed of voxels;

(b) to access data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) to determine for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) to compare characteristics of each of the image areas corresponding to the same voxel;

(e) to remove a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent thereby producing a smaller voxel volume;

(g) to access data representing a further image of the object recorded at a different camera position from the first set of images;

(h) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in the further image;

(i) to compare the characteristic of the image area of the further image with the characteristic already associated with that voxel;

(j) to remove a voxel in response to an inconsistency in the characteristics compared at step (i), thereby producing a smaller voxel space; and

(l) to store the resulting voxel space as an modified representation of the three-dimensional object surface.

77. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, apparatus for processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising:

a processor configured by processor instructions to operate:

(a) to define a volume containing the object as an initial voxel space formed of voxels;

(b) to access data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) to compare characteristics of each of the image areas corresponding to the same voxel;

(e) to remove a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent thereby producing a smaller voxel volume;

(g) to access data representing a second set of images consisting of a sub-set of the first set and a further image of the object recorded at a different camera position from the first set of images;

(h) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each of the second set of images;

(i) to compare the characteristics of the image areas in each of the second set of images;

(j) to remove a voxel in response to an inconsistency in the characteristics compared at step (i), thereby producing a smaller voxel space; and

(l) to store the resulting voxel space as an updated representation of the three-dimensional object surface.

78. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, an improvement comprising apparatus for processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising:

a processor configured by processor instructions to operate:

(a) to define a volume containing the object as an initial space formed of voxels;

(b) to access data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) to determine for each voxel of the voxel space that is not occluded by another voxel, the area

corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) to compare characteristics of each of the image areas corresponding to the same voxel;

(e) to remove a voxel in response to the characteristics of the image areas corresponding to that voxel being inconsistent thereby producing a smaller voxel volume;

(g) to access data representing a further image of the object recorded at a different camera position from the first set of images;

(h) to determine, for each voxel of the voxel space that is not occluded by another voxel,. the area corresponding to that voxel in the further image;

(i) to compare the characteristic of the image area of the further image with the characteristic already associated with that voxel;

(j) to remove a voxel in response to an inconsistency in the characteristics compared at step (i), thereby producing a smaller voxel space; and

(l) to store the resulting voxel space as an modified representation of the three-dimensional object surface.

79. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, an improvement comprising apparatus for processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising:

a processor configured by processor instructions to operate:

(a) to define a volume containing the object as an initial voxel space formed of voxels;

(b) to access data representing a first set of images of the object each recorded at a different camera position with respect to the object;

(c) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(d) to compare characteristics of each of the image areas corresponding to the same voxel;

(e) to remove a voxel in response to the characteristics of the image areas corresponding to that

voxel being inconsistent thereby producing a smaller voxel volume;

(g) to access data representing a second set of images consisting of a sub-set of the first set and a further image of the object recorded at a different camera position from the first set of images;

(h) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each of the second set of images;

(i) to compare the characteristics of the image areas in each of the second set of images;

(j) to remove a voxel in response to an inconsistency in the characteristics compared at step (i), thereby producing a smaller voxel space; and

(l) to store the resulting voxel space as an updated representation of the three-dimensional object surface.

80. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, a method of processing

the image data to derive a representation of a three-dimensional surface of the object, the method comprising the steps of:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) checking to see if a voxel meets at least one criterion by projecting that voxel into at least one of the images;

(d) if the voxel does not meet said at least one criterion, dividing the voxel into subsidiary voxels; and

(e) then checking to see if the subsidiary voxels meets at least one criterion by projecting the subsidiary voxels into at least one of the images.

81. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, a method of processing the image data to derive a representation of a three-

dimensional surface of the object, the method comprising the steps of:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) determining the area corresponding to a given voxel in each image in which the voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the given voxel;

(e) deriving from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel;

(f) sub-dividing a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and repeating steps (c) to (e) for each subsidiary voxel;

(g) in response to a subsidiary voxel having a derived value exceeding a threshold value and a size greater than a minimum size, sub-dividing that subsidiary voxel into subsidiary voxels and repeating steps (c) to (e) for each subsidiary voxel of that subsidiary voxel;

(h) removing any subsidiary voxel of the minimum size having a derived value exceeding the threshold value; and

(i) repeating steps (c) to (h) for each voxel that is not occluded by another voxel to provide a representation of the three-dimensional object surface consisting of the remaining non-occluded voxels and subsidiary voxels.

82. In a method of processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, an improvement comprising processing the image data to derive a computer representation of a three-dimensional surface of the object by:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) determining the area corresponding to a given voxel in each image in which that voxel is visible.

83. In a method of processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, an improvement comprising processing the image data to derive a computer representation of a three-dimensional surface of the object by:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) determining the area corresponding to a given voxel in each image in which the voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the given voxel;

(e) deriving from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel;

(f) sub-dividing a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and repeating steps (c) to (e) for each subsidiary voxel;

(g) in response to a subsidiary voxel having a derived value exceeding a threshold value and a size greater than a minimum size, sub-dividing that subsidiary voxel into subsidiary voxels and repeating steps (c) to (e) for each subsidiary voxel of that subsidiary voxel;

(h) removing any subsidiary voxel of the minimum size having a derived value exceeding the threshold value; and

(i) repeating steps (c) to (h) for each voxel that is not occluded by another voxel to provide a representation of the three-dimensional object surface consisting of the remaining non-occluded voxels and subsidiary voxels.

84. In a method of processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, a method for processing the image data to derive a computer

representation of a three-dimensional surface of the object by:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) determining the area corresponding to a given voxel in each image in which that voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the given voxel;

(e) deriving from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel;

(f) sub-dividing a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and repeating steps (c) to (e) for each subsidiary voxel;

(g) removing any subsidiary voxel having a derived value exceeding a threshold value; and

(h) repeating steps (c) to (g) for each voxel that is not occluded by another voxel to provide a representation of the three-dimensional object surface consisting of the remaining non-occluded voxels and subsidiary voxels.

85. In a method of processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and the camera positions to generate the three-dimensional computer model, a method for processing the image data to derive a computer representation of a three-dimensional surface of the object by:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) determining the area corresponding to a given voxel in each image in which the voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the given voxel;

(e) deriving from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel;

(f) sub-dividing a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and repeating steps (c) to (e) for each subsidiary voxel;

(g) in response to a subsidiary voxel having a

derived value exceeding a threshold value and a size greater than a minimum size, sub-dividing that subsidiary voxel into subsidiary voxels and repeating steps (c) to (e) for each subsidiary voxel of that subsidiary voxel;

(h) removing any subsidiary voxel of the minimum size having a derived value exceeding the threshold value; and

(i) repeating steps (c) to (h) for each voxel that is not occluded by another voxel to provide a representation of the three-dimensional object surface consisting of the remaining non-occluded voxels and subsidiary voxels.

86. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising a processor configured by processor instructions to operate:

(a) to define an initial volume containing the object surface as an initial space formed of voxels;

(b) to access data representing images of the object recorded at different camera positions with respect to the object;

(c) to check to see if a voxel meets at least one criterion by projecting that voxel into at least one of the images;

(d) if the voxel does not meet said at least one criterion, to divide the voxel into subsidiary voxels; and

(e) then to check to see if the subsidiary voxels meets at least one criterion by projecting the subsidiary voxels into at least one of the images.

87. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of

the object, the apparatus comprising a processor configured by processor instructions:

(a) to define an initial volume containing the object surface as an initial space formed of voxels;

(b) to access data representing images of the object recorded at different camera positions with respect to the object;

(c) to determine the area corresponding to a given voxel in each image in which the voxel is visible;

(d) to compare characteristics of each of the image areas corresponding to the given voxel;

(e) to derive from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel;

(f) to sub-divide a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and repeating steps (c) to (e) for each subsidiary voxel;

(g) in response to a subsidiary voxel having a derived value exceeding a threshold value and a size greater than a minimum size, to sub-divide that subsidiary voxel into subsidiary voxels and to repeat steps (c) to (e) for each subsidiary voxel of that subsidiary voxel;

(h) to remove any subsidiary voxel of the minimum size having a derived value exceeding the threshold value; and

(i) to repeat steps (c) to (h) for each voxel that is not occluded by another voxel to provide a representation of the three-dimensional object surface consisting of the remaining non-occluded voxels and subsidiary voxels.

88. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, an improvement comprising apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising a processor configured by processor instructions to operate:

(a) to define an initial volume containing the object surface as an initial space formed of voxels;

(b) to access data representing images of the object recorded at different camera positions with respect to the object;

(c) to determine the area corresponding to a given voxel in each image in which that voxel is visible;

(d) to compare characteristics of each of the image areas corresponding to the given voxel;

(e) to derive from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel;

(f) to sub-divide a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and to repeat steps (c) to (e) for each subsidiary voxel;

(g) to remove any subsidiary voxel having a derived value exceeding a threshold value; and

(h) to repeat steps (c) to (g) for each voxel that is not occluded by another voxel to provide a representation of the three-dimensional object surface consisting of the remaining non-occluded voxels and subsidiary voxels.

89. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining

camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, an improvement comprising apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising a processor configured by processor instructions:

(a) to define an initial volume containing the object surface as an initial space formed of voxels;

(b) to access data representing images of the object recorded at different camera positions with respect to the object;

(c) to determine the area corresponding to a given voxel in each image in which the voxel is visible;

(d) to compare characteristics of each of the image areas corresponding to the given voxel;

(e) to derive from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel;

(f) to sub-divide a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and repeating steps (c) to (e) for each subsidiary voxel;

(g) in response to a subsidiary voxel having a derived value exceeding a threshold value and a size greater than a minimum size, to sub-divide that subsidiary voxel into subsidiary voxels and to repeat steps (c) to (e) for each subsidiary voxel of that subsidiary voxel;

(h) to remove any subsidiary voxel of the minimum size having a derived value exceeding the threshold value; and

(i) to repeat steps (c) to (h) for each voxel that is not occluded by another voxel to provide a representation of the three-dimensional object surface consisting of the remaining non-occluded voxels and subsidiary voxels.

90. In a method of processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and camera positions to generate the three-dimensional computer model, an improvement comprising processing the image data to derive a computer representation of a three-dimensional surface of the object by:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) determining the area corresponding to a given voxel in each image in which that voxel is visible;

(d) determining a colour space value for each pixel of each area where each colour space value encompasses a range of pixel colour values;

(e) comparing the colour space values for each of the image areas corresponding to the same voxel; and

(f) removing the voxel only if the image regions do not share at least one colour space value.

91. In a method of processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and using the images and camera positions to generate the three-dimensional computer model, an improvement comprising processing the image data to derive a computer representation of a three-dimensional surface of the object by:

(a) defining an initial volume containing the object surface as an initial space formed of voxels;

(b) accessing data representing images of the object recorded at different camera positions with respect to the object;

(c) determining the area corresponding to a voxel in each image in which that voxel is visible;

(d) comparing characteristics of each of the image areas corresponding to the same voxel;

(e) deriving from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the voxel; and, when the derived value for a voxel exceeds a threshold value:

(i) sub-dividing the voxel into subsidiary voxels;

(ii) determining the region corresponding to each sub-voxel in each image in which that sub-voxel is visible;

(iii) comparing characteristics of the image regions; and

(iv) removing the voxel only if there is no set of regions which contains a region from each image and for which the characteristics correspond.

92. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, apparatus for processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising a processor configured by processor instructions to operate:

(a) to define an initial volume containing the object surface as an initial space formed of voxels;

(b) to access data representing images of the object recorded at different camera positions with respect to the object which data provides a colour value for each pixel of each image;

(c) to determine the area corresponding to a voxel in each image in which that voxel is visible;

(d) to determine a colour space value for each pixel of each area where each colour space value encompasses a range of pixel colour values;

(e) to compare the colour space values for each of the image areas corresponding to the same voxel; and

to remove the voxel only if the image regions do not share at least one colour space value.

93. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, apparatus for processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising a processor configured by processor instructions to operate:

(a) to define an initial volume containing the object surface as an initial space formed of voxels;

(b) to access data representing images of the object recorded at different camera positions with respect to the object;

(c) to determine the area corresponding to a voxel in each image in which that voxel is visible;

(d) to compare characteristics of each of the image areas corresponding to the same voxel;

(e) to derive from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the voxel; and, when the derived value for a voxel exceeds a threshold value:

(i) to sub-divide the voxel into subsidiary voxels;

(ii) to determine the region corresponding to each sub-voxel in each image in which that sub-voxel is visible;

(iii) to compare characteristics of the image regions; and

(iv) to remove the voxel only if there is no set of regions which contains a region from each image and for which the characteristics correspond.

94. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, an improvement comprising apparatus for processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising a processor configured by processor instructions to operate:

(a) to define an initial volume containing the object surface as an initial space formed of voxels;

(b) to access data representing images of the object recorded at different camera positions with respect to the object which data provides a colour value for each pixel of each image;

(c) to determine the area corresponding to a voxel in each image in which that voxel is visible;

(d) to determine a colour space value for each pixel of each area where each colour space value encompasses a range of pixel colour values;

(e) to compare the colour space values for each of the image areas corresponding to the same voxel; and

to remove the voxel only if the image regions do not share at least one colour space value.

95. In an image processing system for processing image data defining images of an object to generate a three-dimensional computer model of the object by determining camera positions at which the images were recorded and by using the images and the camera positions to generate the three-dimensional computer model, an improvement comprising apparatus for processing the image data to derive a computer representation of a three-dimensional surface of the object, the apparatus comprising a processor configured by processor instructions to operate:

(a) to define an initial volume containing the object surface as an initial space formed of voxels;

(b) to access data representing images of the object recorded at different camera positions with respect to the object;

(c) to determine the area corresponding to a voxel in each image in which that voxel is visible;

(d) to compare characteristics of each of the image areas corresponding to the same voxel;

(e) to derive from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the voxel; and, when the derived value for a voxel exceeds a threshold value:

(i) to sub-divide the voxel into subsidiary voxels;

(ii) to determine the region corresponding to each sub-voxel in each image in which that sub-voxel is visible;

(iii) to compare characteristics of the image regions; and

(iv) to remove the voxel only if there is no set of regions which contains a region from each image and for which the characteristics correspond.

96. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions, the apparatus comprising:

a viewing volume determiner for determining the viewing volume for each camera position;

a bound volume determiner for determining the volume bounded by the intersection of the viewing volumes; and

an initial space setter for setting the bounded volume as an initial space for use in deriving a representation of a three-dimensional surface of the object using said images.

97. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

a viewing volume determiner for determining the viewing volume for each camera position at which an image was taken;

a bound volume determiner for determining the volume bounded by the intersection of the viewing volumes;

a divider for dividing the bounded volume into voxels to form an initial voxel space; and

a processor operable:

(i) to determine, for a voxel that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is represented;

(ii) to compare characteristics of each of the image areas corresponding to the same voxel; and

(iii) to remove a voxel when the characteristics of the image areas corresponding to that voxel are inconsistent.

98. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

an initial volume determiner for defining an initial volume containing the object as an initial space formed of voxels, and

a processor operable:

(i) to access data representing a first set of images of the object each recorded at a respective one of a number of different camera positions with respect to the object;

(ii) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area

corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(iii) to compare characteristics of each of the image areas corresponding to the same voxel to remove any voxel have inconsistent characteristics and to store the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space;

(iv) then to access data representing a further image of the object recorded at a different camera position from the first set of images;

(v) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in the further image;

(vi) to compare the characteristic of the image area in the further image with the characteristic already associated with that voxel;

(vii)to remove any voxel for which the characteristic of the image area of the further image is inconsistent with that already associated with that voxel; and

(viii)to store the resulting voxel space as modified representation of the three-dimensional object surface.

99. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

an initial volume definer for defining an initial volume containing the object as an initial voxel space formed of voxels; and

a processor operable:

(i) to access data representing a first set of images of the object each recorded at a respective different one of a number of different camera positions with respect to the object;

(ii) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the first set of images in which that voxel is visible;

(iii)to compare characteristics of each of the image areas corresponding to the same voxel;

(iv) to remove any voxel having inconsistent characteristics and to store the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space;

(v) then to access data representing a second set of images consisting of a sub-set of the first set and a further image of the object recorded at a different camera position from the first set of images;

(vi) to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image of the second set;

(vii)to compare the characteristics of the image areas of second set;

(viii)to remove any voxel having inconsistent characteristics in the second set of images to store the resulting voxel space as an updated representation of the three-dimensional object surface.

100. In an image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, apparatus comprising:

an initial volume definer for defining an initial volume containing the object surface as an initial space formed of voxels;

a data accessor for accessing data representing images of the object recorded at different camera positions with respect to the object; and

a processor operable:

(c) to check to see if a voxel meets at least one criterion by projecting that voxel into at least one of the images;

(d) if the voxel does not meet said at least one criterion, to divide the voxel into subsidiary voxels; and

(e) then to check to see if the subsidiary voxels meets at least one criterion by projecting the subsidiary voxels into at least one of the images.

101. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

an initial volume definer for defining an initial volume containing the object surface as an initial space formed of voxels;

a data accessor for accessing data representing images of the object recorded at different camera positions with respect to the object; and

a processor operable:

(i) to determine the area corresponding to a given voxel in each image in which the voxel is visible;

(ii) to compare characteristics of each of the image areas corresponding to the given voxel;

(iii)to derive from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the given voxel;

(iv) to sub-divide a voxel into subsidiary voxels in response to the derived value exceeding a threshold value and to repeat steps (i) to (iii) for each subsidiary voxel;

(v) in response to a subsidiary voxel having a derived value exceeding a threshold value and a size greater than a minimum size, to sub-divide that subsidiary voxel into subsidiary voxels and to repeat (i) to (iii) for each subsidiary voxel of that subsidiary voxel;

(vi) to remove any subsidiary voxel of the minimum size having a derived value exceeding the threshold value; and

(vii) to repeat (i) to (vi) for each voxel that is not occluded by another voxel to provide a representation

of the three-dimensional object surface consisting of the remaining non-occluded voxels and subsidiary voxels.

102. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

an initial volume definer for defining an initial volume containing the object surface as an initial space formed of voxels;

a data accessor for accessing data representing images of the object recorded at different camera positions with respect to the object which data provides a colour value for each pixel of each image; and

a processor operable:

(a) to determine the area corresponding to a voxel in each image in which that voxel is visible;

(b) to determine a colour space value for each pixel of each area where each colour space value encompasses a range of pixel colour values;

(c) to compare the colour space values for each of the image areas corresponding to the same voxel; and

(d) to remove the voxel only if the image areas do not share at least one colour space value.

103. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions, a method of processing image data to derive a representation of a three-dimensional surface of the object, the apparatus comprising:

an initial volume definer for defining an initial volume containing the object surface as an initial space formed of voxels;

a data accessor for accessing data representing images of the object recorded at different camera positions with respect to the object; and

a processor operable:

(a) to determine the area corresponding to a voxel in each image in which that voxel is visible;

(b) to compare characteristics of each of the image areas corresponding to the same voxel; and

(c) to derive from the compared characteristics a value representing the degree of any inconsistency between the characteristics of the image areas corresponding to the voxel and, when the derived value for a voxel exceeds a threshold value,

(i) to sub-divide the voxel into subsidiary voxels,

(ii) to determine the region corresponding to each sub-voxel in each image in which that sub-voxel is visible,

(iii) to compare characteristics of the image regions, and

(iv) to remove the voxel only if there is no set of regions which contains a region from each image and for which the characteristics are not inconsistent.

104. Apparatus according to claim 41, wherein the processor means is operable to determine, for each voxel of the voxel space that is not occluded by another voxel, the area corresponding to that voxel in each image in which that voxel is represented or visible by projecting the voxel into the image.

105. Apparatus according to claim 41, wherein the processor means is operable to compare characteristics of each of the image areas corresponding to the same voxel by comparing the colours of each of the image areas.

106. Apparatus according to claim 45, wherein the processor means is operable to compare characteristics of each of the image areas corresponding to the same voxel by comparing the colours of each of the image areas.

107. Apparatus according to claim 49, wherein the processor means is operable to compare characteristics of each of the image areas corresponding to the same voxel by comparing the colours of each of the image areas.

108. Apparatus according to claim 51, wherein the processor means is operable to compare characteristics of each of the image areas corresponding to the same voxel by comparing the colours of each of the image areas.

109. A method according to claim 72, further comprising, before step (g), a step (f) of repeating steps (c) to (e) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space; and after step (j) a step (k) of repeating steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as an updated representation of the three-dimensional object surface.

110. A method according to claim 73, further, comprising, before step (g), a step (f) of repeating steps (c) to (e) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space; and after step (j) a step (k) of repeating steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as an updated representation of the three-dimensional object surface.

111. A method according to claim 74, further comprising, before step (g), a step (f) of repeating steps (c) to (e) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space; and after step (j) a step (k) of repeating steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as an

updated representation of the three-dimensional object surface.

112. A method according to claim 75, further comprising, before step (g), a step (f) of repeating steps (c) to (e) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space; and after step (j) a step (k) of repeating steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as an updated representation of the three-dimensional object surface.

113. Apparatus according to claim 76, wherein the processor is operable to:

(f) repeat steps (c) to (e) until all non-occulded voxels having inconsistent characteristics have been removed and storing the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space; and

(k) repeat steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed.

114. Apparatus according to claim 77, wherein the processor is operable to:

(f) repeat steps (c) to (e) until all non-occulded voxels having inconsistent characteristics have been removed and store the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space; and

(k) repeat steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed.

115. Apparatus according to claim 78, wherein the processor is operable to:

(f) repeat steps (c) to (e) until all non-occulded voxels having inconsistent characteristics have been removed and store the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space; and

(k) repeat steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed.

116. Apparatus according to claim 79, wherein the processor is operable to:

(f) repeat steps (c) to (e) until all non-occulded voxels having inconsistent characteristics have been removed and store the resulting voxel space as a representation of the three-dimensional object surface, together with the characteristic associated with each non-occluded voxel of the resulting voxel space; and

(k) repeat steps (h) to (j) until all non-occluded voxels having inconsistent characteristics have been removed.

117. A method of operating an image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions, the method comprising the steps of:

(a) determining the viewing cone for each camera position;

(b) determining the volume bounded by the intersection of the viewing cones; and

(c) setting the bounded volume as an initial space for use in deriving a representation of a three-dimensional surface of the object using said images.

118. An image processing apparatus for processing image data representing images of an object taken from a plurality of different camera positions, the apparatus comprising:

means for determining the viewing cone for each camera position;

means for determining the volume bounded by the intersection of the viewing cones; and

means for setting the bounded volume as an initial space for use in deriving a representation of a three-dimensional surface of the object using said images.